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(54) Dough mixing

(57) The invention relates to a dough mixing method for use in breadmaking, which comprises mixing together dough ingredients, including ascorbic acid as an improver, in the presence of air or an oxygen-containing gas. The mixing provides sufficient mechanical energy for a sufficient time to develop the gluten in the dough. Excess pressure is applied to the atmosphere around the dough during a first phase of the mixing, and then a reduced pressure is applied during a second phase. Apparatus for carrying out the method is also provided.

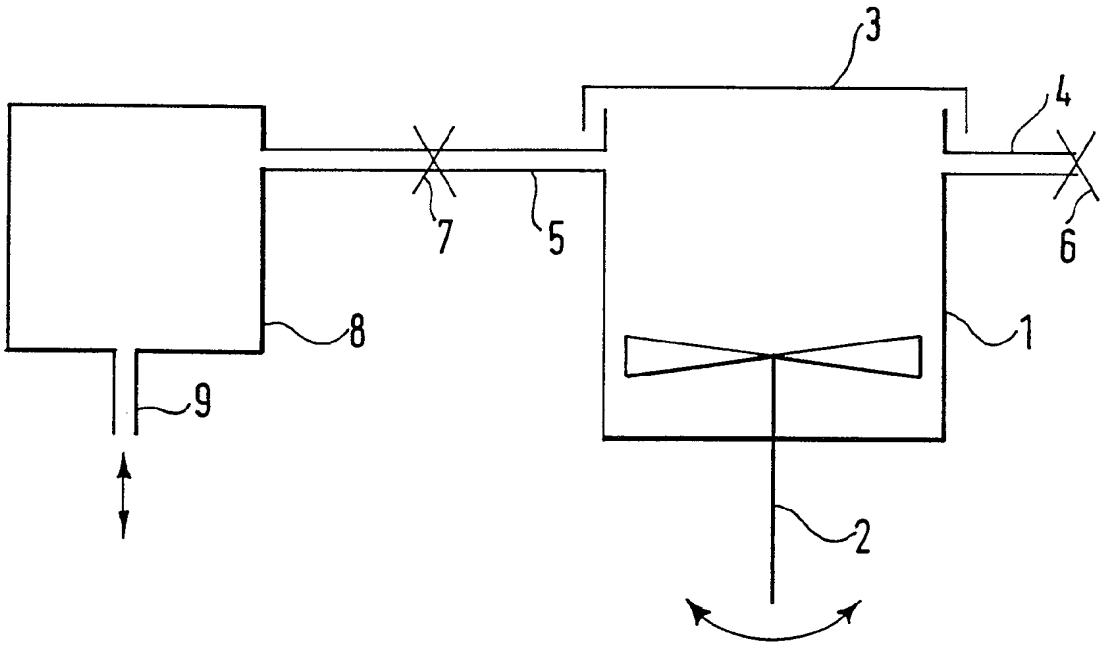

Fig.1.

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At least one drawing originally filed was informal and the print reproduced here is taken from a later filed formal copy.

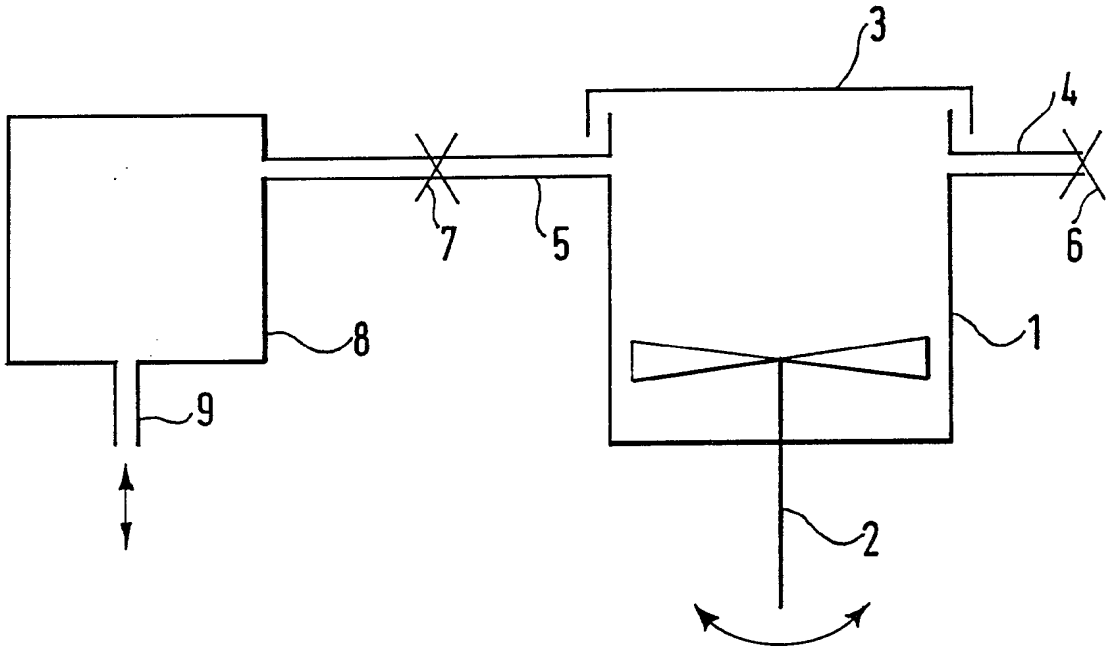

Fig.1.

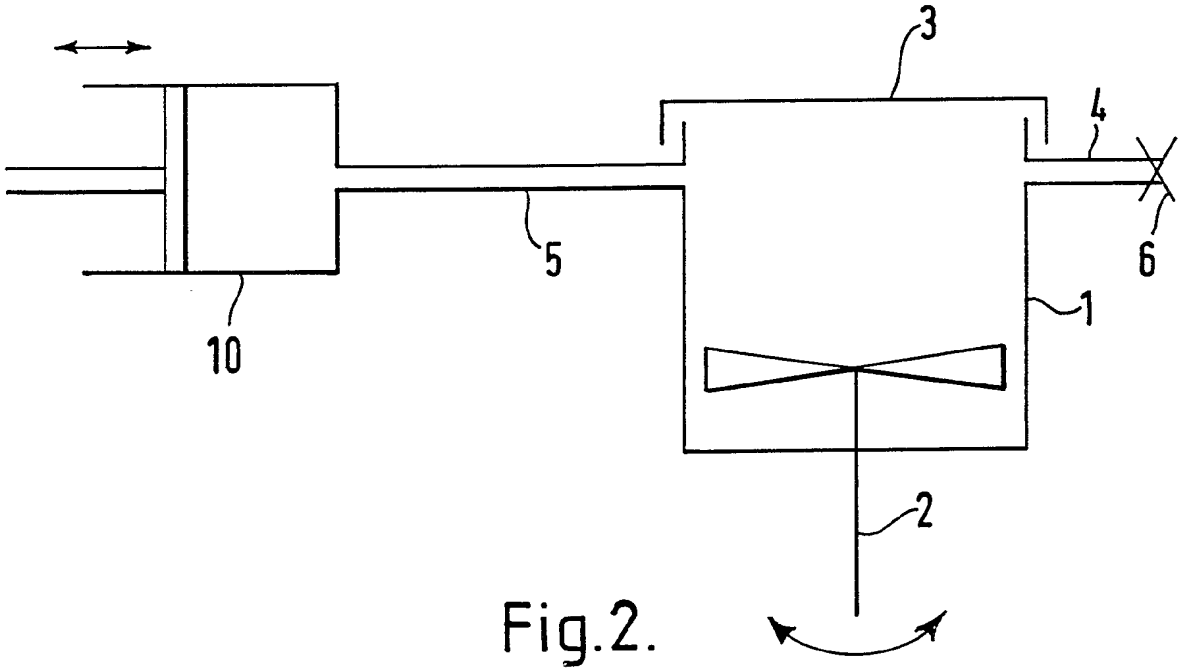

Fig.2.

DOUGH MIXING

This invention relates to dough mixing, and in particular to improvements in dough mixing to maximise the utilisation of ascorbic acid as a bread improver.

The baking industry makes use of improvers for the control of loaf quality and to enable better production of bread using fast processes in modern highly mechanised plants. The use of improvers is not exclusive to large scale production, though the subject of this invention applies more to large scale than any other.

On 1st April 1990 permission to continue to use the improver potassium bromate was withdrawn by the U.K. Government. A similar action has either already taken place in other developed countries or could do so in the foreseeable future.

Bromate was a very versatile improver, acting under all the conditions commonly in use for breadmaking. In particular, it did not require to be converted into another compound to work as an improver, it was unaffected by the atmosphere in the mixing machine bowl and there was synergism between it and ascorbic acid, the other most widely used improver.

The U.K. baking industry now has a choice of only three oxidising improvers, ascorbic acid, azodicarbonamide and chlorine dioxide (a gas treatment used only occasionally at the end of flour milling). Ascorbic acid, which is vitamin C, is the preferred improver, it is the only improver allowed in many countries, including all of the EC. However, it has characteristics which are difficult to deal with in

some breadmaking circumstances. During mixing air is incorporated into the dough, and the oxygen in the air converts the ascorbic acid to dehydroascorbic acid, which is the true oxidising improver. Industrial bakers now have breadmaking problems which are caused by insufficient improvement from ascorbic acid. Though azodicarbonamide is an alternative to ascorbic acid, it is generally less acceptable to consumers and more difficult to control in the bakery because of its rapid and powerful improver action. Some bakers choose not to use azodicarbonamide. Improver chlorine dioxide is very weak, cannot be applied at the bakery and could not, on its own, provide all the improver function required.

The consequences of sub-optimal oxidising improver action are lower loaf volume, increased firmness of the whole loaf and slice (interpreted by consumers as staleness), duller crumb colour and less acceptable eating quality. The extent of the problem is widespread within the UK and will affect breadmaking in all countries using rapid processes with ascorbic acid as the only improver. It is of particular importance where loaf crumb structure is required to be uniform.

In modern breadmaking processes mixing is much more than the homogenous incorporation of the recipe ingredients into a dough. During dough mixing there are three essential factors which must occur simultaneously, as follows:

1. There must be mechanical energy expended at an intensity which is sufficient to develop gluten derived from both the natural protein in flour and from any dried gluten added to raise the flour performance. A high speed, highly powered

mixing machine is required with the ability to impart an energy level of about 11Wh/kg of dough. To be effective the intensity of mixing must impart the required work input in a total mixing time not exceeding about 4 minutes. This mixing machinery is commonly available and used to produce about 80% of all bread made in the U.K. Similar machines are in use in about 30 countries.

2. During mixing air must be mixed into dough to create bubble nuclei and to provide oxygen which is essential for the conversion of ascorbic acid to dehydroascorbic acid (the true oxidising improver). The oxidising improver gives stability to gluten development. The mixing action is required to both beat air in and subdivide it into a uniform structure of very small cells. Oxygen from the air in the dough bubbles is quickly removed by yeast in the recipe, which leaves nitrogen gas to nucleate the structure. The nitrogen bubbles in dough are expanded as carbon dioxide produced by yeast fermentation diffuses into them. When the expanded structure is set during baking it becomes the crumb structure of the loaf.

3. The correct subdivision of air in dough during mixing, required to produce a uniform loaf structure acceptable for most breads, is essential but difficult to achieve. It is substantially more successful when a partial vacuum is applied during mixing. This produces bubbles of smaller diameter which have greater stability during subsequent machining. The application of a partial vacuum removes air which in turn decreases oxidation from ascorbic acid

and adversely affects oxidising improvement required for dough development and bubble structure stability.

Restricting air incorporation during mixing, by applying a partial vacuum, did not matter when bromate and ascorbic acid could be used together. It is a problem when ascorbic acid is on its own. Bakers now have loaf volume and structure problems caused by insufficient oxidation from the improver. Bakers try to cover-up these loaf problems by the use of more expensive higher protein flour, adding emulsifier, increasing enzyme addition and sometimes by taking all three of these measures. However, these measures do not provide a satisfactory solution to the problem.

It is known that improver action from ascorbic acid can be increased by delaying the application of partial vacuum until about the second half of mixing. That means mixing at atmospheric pressure for about 2 minutes and pulling partial vacuum for the remainder of the time until the required work input has been achieved, approximately a further 2 minutes in a large size machine. Structure control is not quite as good as when there is partial vacuum throughout mixing, but oxidising improver action is better, though less than optimum.

The present invention provides a solution to the problem outlined above by the application of a pressure/vacuum sequence to provide adequate air in the atmosphere during the first phase for ascorbic acid conversion to dehydroascorbic acid, followed by rapid application of partial vacuum for bubble structure control.

The invention thus provides a dough mixing method

for use in breadmaking, which comprises mixing together dough ingredients, including ascorbic acid as an improver, in the presence of air or an oxygen-containing gas, the mixing providing sufficient mechanical energy for a sufficient time to develop the gluten in the dough, characterised in that excess pressure is applied to the atmosphere around the dough during a first phase of the mixing, and then a reduced pressure is applied during a second phase.

The invention also provides apparatus for carrying out the above method, comprising a mixing chamber having a mixing element and a lid which is movable between open and closed positions, the lid being capable of making sealing contact with the chamber when in the closed position, characterised in that means are provided for successively applying excess pressure and then reduced pressure to the interior of the mixing chamber when the lid is closed.

The mixing machine bowl is a pressure vessel also capable of withstanding a high partial vacuum. External to the mixing chamber is another pressure/vacuum chamber with a valve connecting it to the mixing vessel.

In operation the external pressure vessel is pressurised while the mixing vessel is loaded with ingredients. At the start of mixing, pressure from the external pressure vessel is transferred to the mixing machine bowl for the first part of mixing to encourage oxidising improvement from ascorbic acid. While this is taking place the external vessel creates a partial vacuum enabling rapid change-over in the mixing vessel from pressure to partial vacuum to create the desired bubble structure. After transfer of vacuum the external vessel is again pressurised and

so on.

The invention enables better improvement from ascorbic acid, resulting in maximum performance of flour properties, and control of bubble structure. Further exploitation of partial vacuum, which under these combined conditions could be used at lower pressure to further improve dough machining and handling properties, may be possible.

A preferred method of mixing is to operate the mixing elements in opposite directions during the pressure and vacuum stages. During the pressure stage, mixing action should beat air into the dough structure by having a wide face to the mixing element moving into the dough. During the vacuum stage the leading edges of the mixing element have a cutting action to subdivide and open large bubbles for air removal by vacuum.

The invention can also be used with other gases and combinations of oxygen and air to provide higher oxygen concentration in the mixing machine headspace, already known to be successful at atmospheric pressure.

Reference is now made to the accompanying drawings, in which:

Figure 1 is a diagrammatic representation of one embodiment of apparatus for use in the present invention; and

Figure 2 is a diagrammatic representation of another embodiment of apparatus for use in the invention.

Figure 1 shows a mixer bowl 1 provided with a reversible beater drive 2. The bowl is provided with a lid 3 which can be opened for the entry and removal of mixing ingredients. In the closed position, the lid is sealed to the rim of the bowl so that the bowl then becomes a pressure/vacuum-tight container. The bowl 1 is provided with first and second pipelines 4 and 5 respectively. The first pipeline 4 is provided with an adjustable pressure relief valve 6 which is adapted to release pressure from the bowl if it rises above a safe limit. The pipeline 5 is provided with a valve 7 and communicates between the interior of the bowl 1 and a pressure/vacuum tank 8. The tank 8 is in turn provided with a pressure/vacuum supply 9.

In use, the dough ingredients are placed in the bowl 1 and the lid 3 is sealed. The tank 8 has previously been placed under pressure, and the valve 7 is opened to increase the pressure in the bowl 1. The valve 7 is then closed, and the dough ingredients are mixed in the bowl 1 by the beater. In the meanwhile, the tank 8 is evacuated. After a suitable time interval, while mixing in the bowl 1 is continued, excess pressure is released through the valve 6. The valve 6 is then closed and the valve 7 is opened to reduce the pressure in the bowl 1. The valve 7 is closed and the tank 8 is returned to atmospheric pressure. After completion of mixing, the valve 7 is opened to return the interior of the bowl 1 to atmospheric pressure. The lid 3 is opened and the mixed dough is removed.

When the pressure in the bowl 1 is changed from excess pressure to reduced pressure, the direction of rotation of the beater drive 2 is reversed. The blades of the beater have thick edges on one side and narrow cutting edges on the opposite side. During the

excess pressure phase, the thick edges are the leading edges. During the reduced pressure phase, the thin edges are the leading edges.

The apparatus shown in Figure 2 is generally similar in construction and operation to that of Figure 1, and corresponding members have the same reference numerals. However, in Figure 2, a pressure/vacuum tank is not employed, and instead the pipeline 5 communicates directly with a vacuum/pressure device 10 which is capable of increasing pressure or pulling a vacuum directly to the interior of the mixer bowl 1.

The invention is further illustrated by the following example of breadmaking by the Chorleywood Bread process (CBP) adapted according to the present invention.

EXAMPLE

Breadmaking process: CBP

Bread type: 800g, white, four-piece, lidded, long-loaf

Mixing machine: High-speed

Recipe:

	% of flour weight
Flour	100
Yeast	2.5
Salt	2.0
Water	62.0
Fat	1.0
Improver	1.0

Dough processing:

Mixing machine	:	High-speed
Work input	:	Up to 11 Wh/kg

First stage of mixing

Pressure	:	Up to 3 Bar, typically 1.5 to 2.0 Bar
Mixing element	:	Direction for beating in air preferred

Second stage of mixing

Pressure	:	Partial vacuum, typically 0.5 to 0.25 Bar
Mixing element	:	Direction to cut through dough preferred
Dough temperature	:	30.5 +/- 1°C
Scaling	:	850 to 930g
First moulding	:	Into a Ball by Conical moulder
First proof	:	2 to 6 min at ambient temperature
Final	:	Four-piece
Pan size	:	Approx Top 250mm x 122mm, 125mm deep
Shape	:	Lidded
Proving conditions	:	About 43°C, humidity to prevent skinning
Proving height	:	About 2cm below pan lip
Baking temperature	:	Average 240 to 250°C
Oven type	:	Various
Baking time	:	18 to 30 min
Baking humidity	:	Steam injected as required
Cooling	:	) As appropriate for the variety
Storage	:	)

CLAIMS:

1. A dough mixing method for use in breadmaking, which comprises mixing together dough ingredients, including ascorbic acid as an improver, in the presence of air or an oxygen-containing gas, the mixing providing sufficient mechanical energy for a sufficient time to develop the gluten in the dough, characterised in that excess pressure is applied to the atmosphere around the dough during a first phase of the mixing, and then a reduced pressure is applied during a second phase.

2. A method according to claim 1, in which the total energy provided by the mixing is from 5 to 20 Wh/kg of dough over a total mixing time of from 1 to 6 minutes.

3. A method according to claim 1 or 2, in which the first and second phase of mixing each last for 1 to 3 minutes.

4. A method according to any of claims 1 to 3, in which the pressure applied during the first phase is in the range of from 1.05 Bar to 3.0 Bar.

5. A method according to any of claims 1 to 4, in which the pressure applied during the second phase is in the range of from 0.5 Bar to 0.25 Bar.

6. A method according to any of claims 1 to 5, in which ascorbic acid is the sole oxidising improver in the dough and the mixing is carried out in the presence of air.

7. Apparatus for carrying out a method according to any preceding claim, comprising a mixing chamber having a mixing element and a lid which is movable between open and closed positions, the lid being capable of making sealing contact with the chamber when in the closed position, characterised in that means are provided for successively applying excess pressure and then reduced pressure to the interior of the mixing chamber when the lid is closed.

8. Apparatus according to claim 7, in which the mixing chamber is in communication with a pressure/vacuum chamber by way of a valve means, whereby, by opening the valve means, pressure in the mixing chamber can be increased or vacuum obtained, and then maintained in the mixing chamber by closing the valve means.

9. Apparatus according to claim 7 or 8, in which the mixing element is a rotatable shaft having stirrer blades with a relatively wide edge on one side and relatively narrow edge on an opposing side, and the direction of rotation is reversible, so that the leading edges of the blades during mixing can be selected to be relatively wide or relatively narrow.

Patents Act 1977
Examiner's report to the Comptroller under Section 17 (The Search Report)

Application number: GB 9204883.4

Relevant Technical fields

(i) UK Cl (Edition L) A2A, A1 A2B BMB1, BMB31, BMB39 B1C, CAY, CPB, CPD, CPE, CPG, CPA

(ii) Int Cl (Edition 5) A21C, B01F

Search Examiner: B J GARDNER

Databases (see over)

(i) UK Patent Office

(ii) ONLINE DATABASE: WPI, US CLAIMS

Date of Search:

Documents considered relevant following a search in respect of claims 1-9

Category (see over)	Identity of document and relevant passages	Relevant to claim(s)
X	GB 1044616 (GILBERT) see particularly claims	1 and 7 at least

Category	Identity of document and relevant passages	Relevant to claim(s)

Categories of documents

X: Document indicating lack of novelty or of inventive step.

Y: Document indicating lack of inventive step if combined with one or more other documents of the same category.

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P: Document published on or after the declared priority date but before the filing date of the present application.

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